Space Weather Technical Forecast

Issued on Sunday, 17 April 2022 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely (R1/R2 Radio Blackouts). Active Electron Fluence likely day 1 or day 2 (17th or 18th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with one M1 flare in the last 24 hours, from AR2994 Hhx/alpha, a newly numbered region near the northeast limb. AR2993 Cho/Beta to the north of this region also rotated onto the disc, and combined these two are generating frequent C-flares. There are a total of six numbered, and one unnumbered region on the disc, however all other sunspot regions are currently much smaller than these regions. Some slow growth has been observed in AR2990 Dro/Beta east of the north centre disc, new region AR2992 Cao/Beta in the southwest, and new unnumbered region Axx/alpha in south centre disc. AR2991 Hax/alpha in the southeast and AR2989 Bxo/beta in the northeast are currently stable. A filament is currently lifting from the south centre disc at time of issue, however no Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR and ACE at L1 continued to be elevated due to ongoing fast wind influence of CH74. Solar wind speeds were elevated to strong, easing from a peak near 700 km/s to around 500-550 km/s. The density was mainly average to below average. The interplanetary magnetic field (IMF) strength, Bt, was weak to moderate, peaking just below 10nT around 16/0510 UTC. The north-south component, Bz, was initially positive (northward), peaking 9nT at 16/0827UTC, before becoming more variable between +6nT and -6nT. The phi angle has been mostly positive (away from the Sun). Geomagnetic activity has been Quiet to Unsettled through this period (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 at GEO was at background levels. The high energy electron flux (greater than 2 MeV) rose from normal background to moderate to high levels after 16/1200 UTC, peaking at 1230 pfu at 15/1650 UTC. The associated 24 hour electron fluence has been below the Active threshold throughout but on a brief rising trend, with observed fluence of 3.98e7 integrated pfu at 17/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Moderate to Low with an ongoing likelihood of M-flares through the period, primarily due to active regions AR2993 and AR2994 that have recently rotated onto the northeast disc. These also give an above background chance of activity increasing to strong with a very slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth directed CMEs. Earth is embedded within the fast wind of CH74/+ and expected to see further fast wind enhancement through the period from CH75/+ days 1-2 (17th and 18th) and then CH76/- later in the period, most likely day 4 (20th). However confidence is low regarding the strength and timing of these enhancements. Quiet to Active geomagnetic activity forecast, with a slight chance of G1/Minor Storms. These most likely on day 4 (20th).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is

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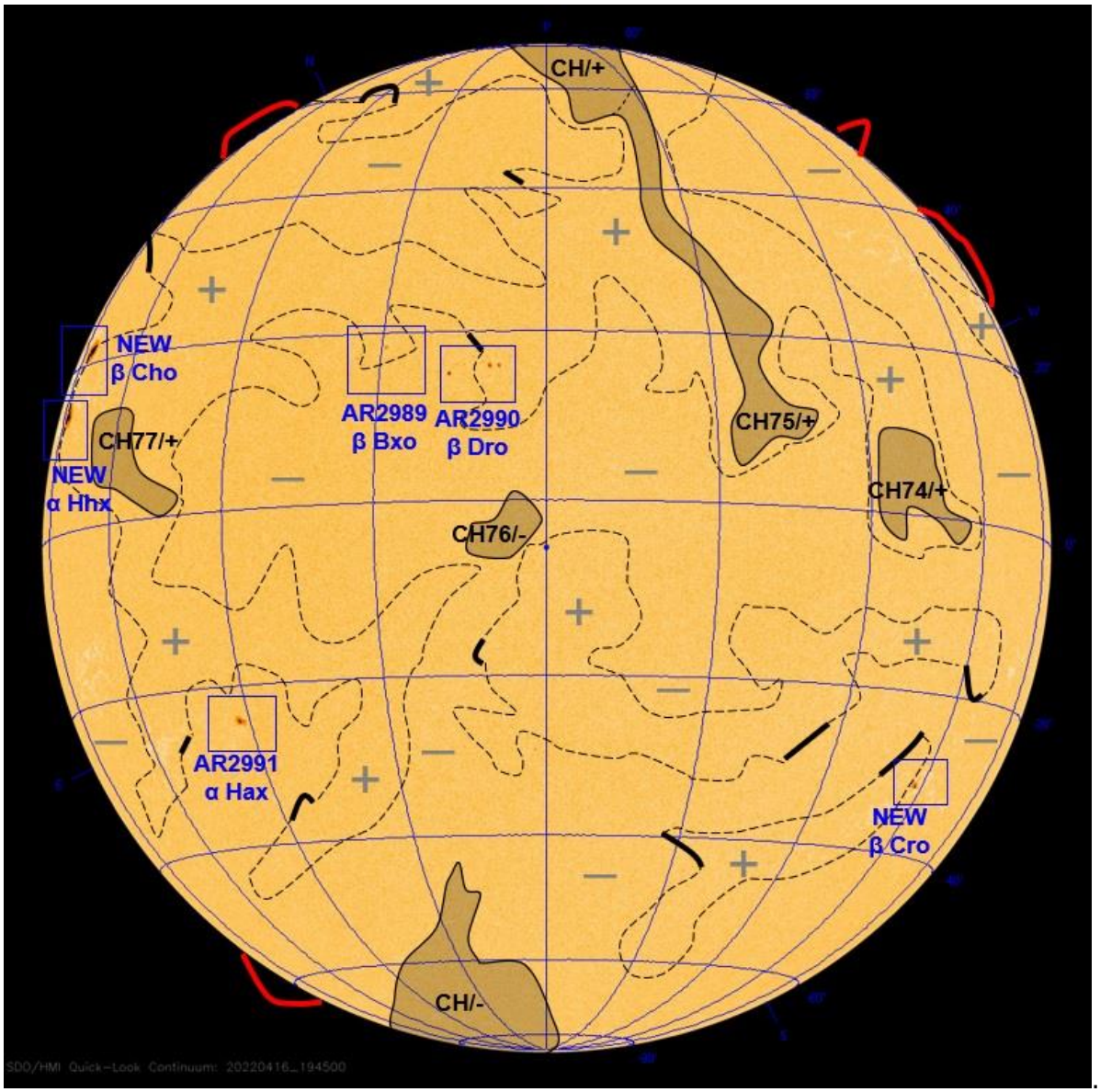
expected to be at background levels, with just a slight increase in probability by the end of the period as AR2993 and AR2994 move westwards across the Earth-facing solar disc. The high energy electron flux (greater than 2 MeV) is expected to persist at Moderate to High levels, although drop outs are likely from any fast wind arrivals, significantly reducing confidence by day 3 (19th). The associated 24 hour electron fluence is likely to rise above the Active (1e8 pfu) threshold later day 1 or day 2 (17th and 18th), before likely declining due to any drop outs, and gradual decay of peak flux levels.

Figure 1. Solar Analysis Valid 16/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth directed CMEs. Earth is currently in the fast wind from CH74, with solar winds currently elevated at 500-600km/s. A brief easing of the solar wind to slightly elevated levels is possible day 1 (17th) before the arrival of the fast wind of CH75 is likely to maintain slightly elevated to elevated solar winds into day 3 (19th). These solar winds potentially easing again, before a further fast wind arrival is possible day 4 (20th), from the small CH76/- in centre disc. The timing and strength of these features are low confidence, however with only the latter featuring in persistence data, and a lack of clear data from STEREO-A.

Geomagnetic activity is forecast to be mostly Quiet to Active, with fast wind enhancements through the period giving a very slight chance of G1/Minor storms on days 1-3, (17-19th) but potentially a greater risk on day 4 (20th) when the polarity of the coronal hole suggests more favourable likelihood of a stronger connection (Russell-Mcpherron effect).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	5	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: SDO aia-191 of previous rotation (left) and current (right)

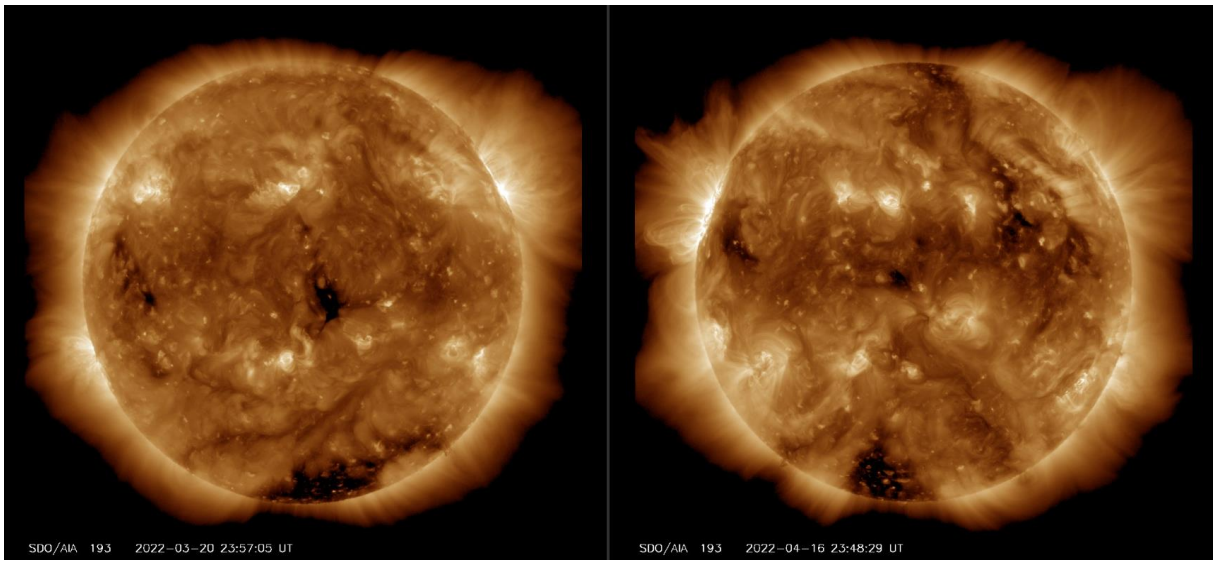

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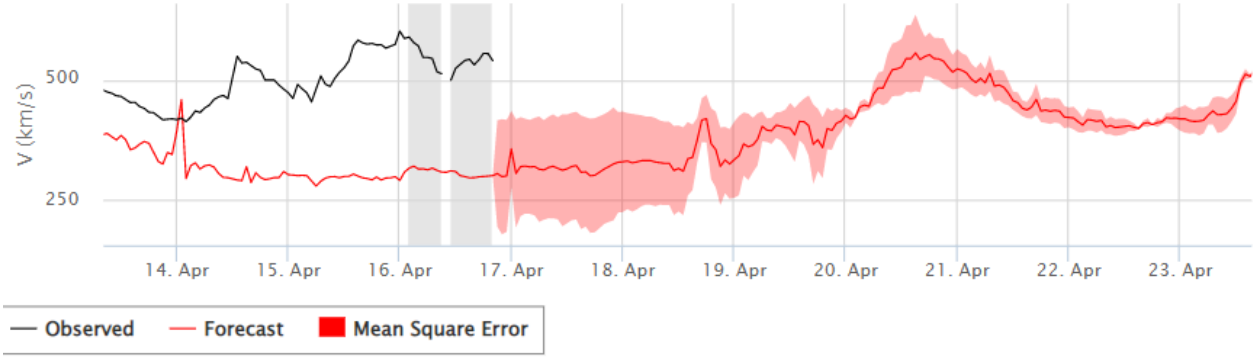
Figure 3: Solar Wind Persistence Model - Enhancement late 19th and 20th likely related to central disc coronal hole (CH76), although appears to be further east (delayed) on this rotation



Radio Blackouts - X-Ray Flares:

Solar Activity is likely to be Moderate with a likelihood for M-flares (R1/R2 Radio blackouts) on each day, primarily from new active regions in the northeast. These also bring a slight risk of isolated X-class flares (R3 Radio blackouts).

These new regions have recently been numbered AR2993 Cho/Beta for the northernmost region and AR2994 Hhx/Beta and they are the likely source of a number of M-flares in the last 2 days. Further complexity is expected to become apparent as they rotate into full view, with their current analysis likely to change. This is supported by STEREO-A euvi imagery which shows a broad area of bright flux, and magnetic looping in the northeast disc, along with notable magnetic looping visible in SDO aia products.

There are five other regions on the disc, four of which are numbered but all small, simple and stable, including AR2989 Bxo/Beta in the northeast disc and AR2991 Hax/alpha in the southeast. Some slight growth has occurred in AR2990 Dro/Beta, also in the northeast approaching the central disc, however this remains small and unlikely a source of major flaring. AR2992 Cao/Beta has also developed in the southwest and was recently numbered, whilst a further unnumbered Axx/alpha emerged in the south centre disc. These will need to be monitored for further growth.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

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Figure 4: GOES 16/17 X-ray Flux

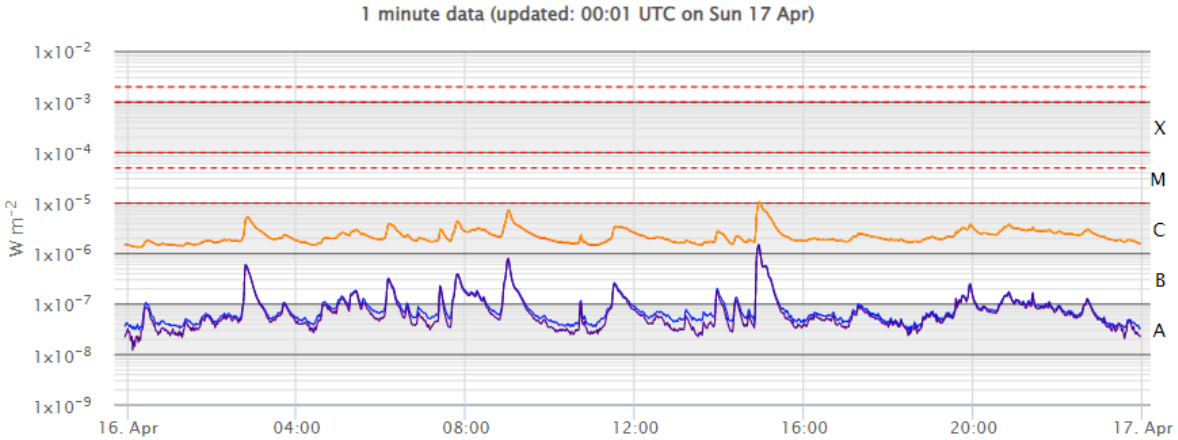
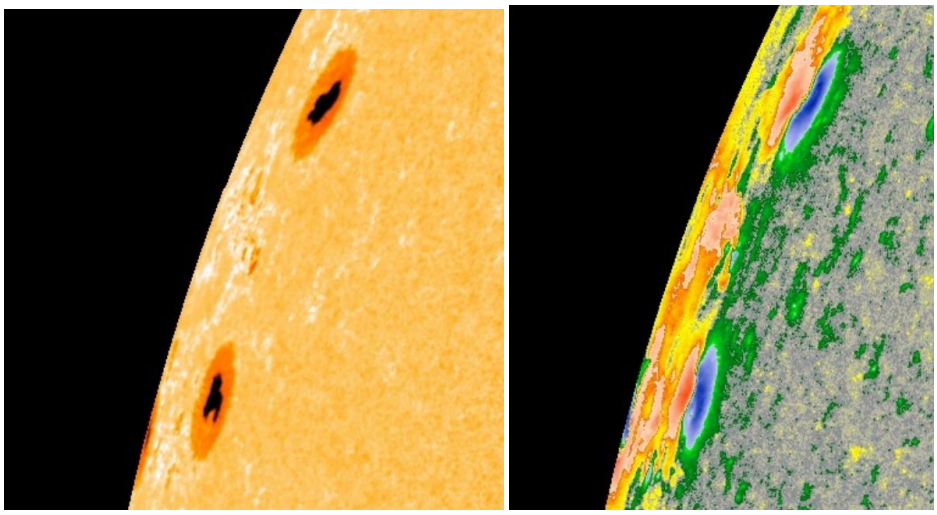


Figure 5: Hi-resolution Intensitygram and Magnetogram of AR2993 and AR2994 in NE.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at background levels, and likely to remain so through the next 4 days. New regions in the northeast have the potential to be followed by a further region(s) associated with ex-2975 and/or ex-2976, which had a history of producing S1 proton events on the previous rotation. As they continue to move into a slightly more favourable location for any such proton events to be observed by Earth, the potential for S1 or above storms increases, albeit still only very slightly.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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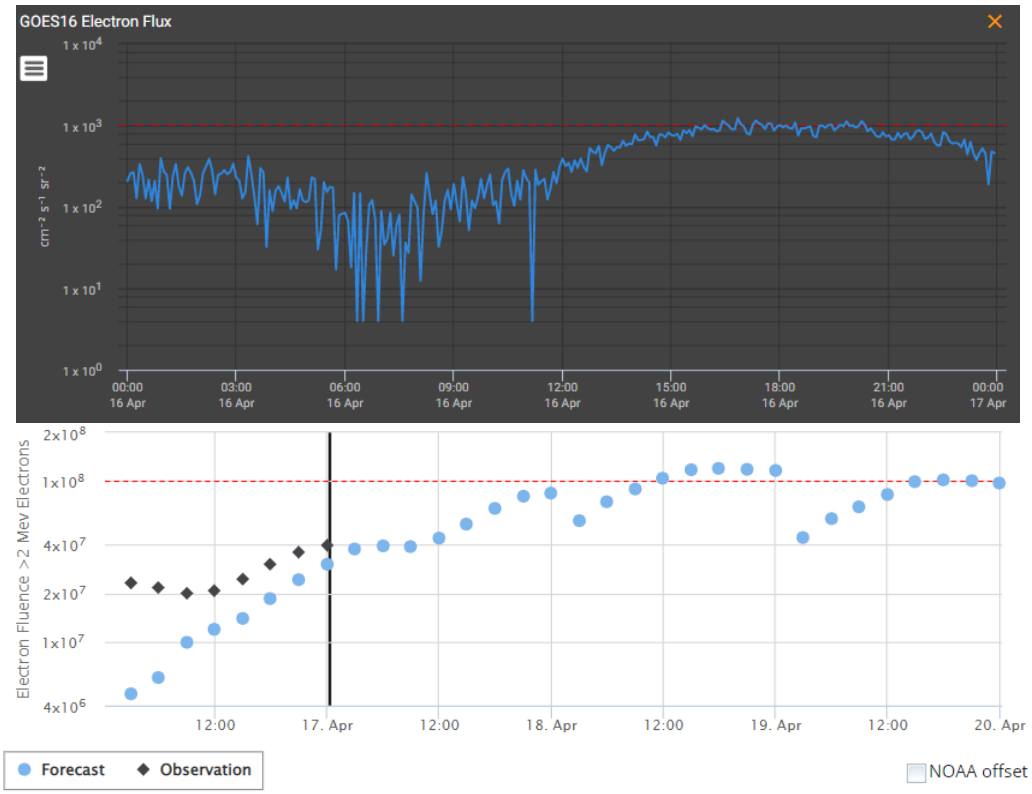
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO has rising to Moderate to High levels since 16/1200 UTC. Peak values are expected to rise day 1 (17th), but likely continuing Moderate to High through the period. Dropouts are possible with induced geomagnetic activity as fast wind arrivals occur, although the timing and strength of these are low confidence, and possible throughout. Recovery of flux levels are likely to follow any dropouts, with Moderate to High levels continuing through the period, but with decreased confidence for reaching high levels, especially day 3 (19th) onward.

The associated 24-hr electron fluence is currently rising, with REFM giving good guidance for the expected trend, although observations are currently running higher than this forecasts. Consequently Fluence is likely to rise above the Active (1e8) threshold day 1 (17th), peaking on the day 2 (18th), before declining again. However confidence becomes low by day 3 (19th), with potential fast wind arrivals and subsequent flux drop outs possible.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	60	70	60	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: GOES-16 >2 MeV Electron Flux (top) and Fluence with REFM (bottom)



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